INVESTIGATOR'S ANNUAL REPORT

United States Department of the Interior

National Park Service

All or some of the information you provide may become available to the public.

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Reporting Year: 2009

Park: Shenandoah NP

Select the type of permit this report addresses: Scientific Study

Name of principal investigator or responsible official: Rebecca Forkner

Office Phone: (703) 993-4683

Mailing address:
Environmental Science & Policy, MSN 5F2

George Mason University

4400 University Drive
Fairfax, VA 22030
USA

Office FAX

Office Email
rforkner@gmu.edu

Additional investigators or key field assistants (first name, last name, office phone, office email)
No co-investigators

Project Title (maximum 300 characters):
Phenological Changes in Insects and Plant Phenolics Along Altitude Gradients

Park-assigned Study or Activity #:	Park-assigned Permit #:	Permit Start Date:	Permit Expiration Date:
SHEN-00355	SHEN-2008-SCI-0016	Jul 17, 2008	Dec 31, 2011

Scientific Study Starting Date: May 01, 2008

Estimated Scientific Study Ending Date: Dec 31, 2008

For either a Scientific Study or a Science Education Activity, the status is:

Continuing

For a Scientific Study that is completed, please check each of the following that applies:

__ A final report has been provided to the park or will be provided to the park within the next two years

__ Copies of field notes, data files, photos, or other study records, as agreed, have been provided to the park

__ All collected and retained specimens have been cataloged into the NPS catalog system and NPS has processed loan agreements as needed

Activity Type:
Research

Subject/Discipline:
Plant Communities (Vegetation)

Purpose of Scientific Study or Science Education Activity during the reporting year (maximum 4000 characters):

Preliminary research indicated that cumulative temperature before leaf fall explained less than 50% of color change in autumn leaves and alone wasn't sufficient to forecast onset of leaf coloring. The goal of our project is to answer several questions regarding the multiple roles of phenolics in plants in order to forecast changes in autumn leaf color due to global warming. First, we will quantify the degree to which individual stressors (e.g., insect damage) alter phenolic concentrations. Next, we will quantify how stressors alter phenolics at different plant developmental stages. Also, we will determine the degree to which changes in phenolics at different developmental stages are related. Lastly, we will determine the relationship between concentrations and visual expression. We will 1) Monitor timing of leaf flush and fall, 2) Measure insect abundance and leaf damage 3 times during the season, 3) Collect leaf material for assays of phenolics 4 times during the season: immediately after leaf flush, mid summer after leaves mature, end of summer prior to chlorophyll degradation, and at peak color change, 4) Quantify leaf color change, 5) Monitor temperature variation to calculate degree day accumulation (DDA) and relate it to leaf flush, fruiting, insect activity, leaf fall, and color change, 6) Experimentally alter leaf damage and UV levels in a factorial experiment.

Findings and status of Scientific Study or accomplishments of Science Education Activity during the reporting year (maximum 4000 characters):

We collected data on autumn leaf coloration and abscission from field sites within the Shenandoah National Park (SNP) at elevations above 2,000 ft (beyond mile marker 19 at Keyser Run and Mathewâ s Arm), as a part of a larger study on the role of insect damage and climate change on leaf phenology in Acer rubrum (red maple). We collected additional data on A. rubrum phenology at field sites at mid-elevations within the National Zoological Park Conservation Research Center (CRC) in Front Royal, VA and at low elevations within the Bull Run â Occoquan Regional Park Watershed in Fairfax County, VA. At all locations, red maple trees were assigned to a control treatment (no manipulation) or an artificial insect damaged simulation treatment, which consisted of holes make with a paper hole-puncher in order to remove 10% of the leaf material on two branches. Control and artificially damaged branches were surveyed throughout the season for densities of leaf-feeding caterpillars and monitored in October at peak leaf flush for rates and timing of leaf abscission and leaf color change. We predicted that low levels of leaf herbivory by native insects would increase amounts of pigment compounds responsible for red coloration in autumn leaves. UV levels were not altered in this field season, nor were leaves collected for phenolic assays. These portions of the project are on hold as we wait for funding from external granting agencies.

Results demonstrated that abscission rates were 8% higher on artificially damaged red maple branches compared to control trees. Artificially damaged red maples also showed higher percentages of leaves with autumn pigmentation and more intense coloration (i.e. % of leaf area with color and degree of redness) compared to leaves of branches on untreated control trees. Additionally, there was an elevation by treatment interaction. Specifically, rates of leaf loss for damaged trees were greater at high elevations. Moreover, control trees had increased color displays compared to damaged trees for mid-elevation sites within CRC.

Results indicate that while natural levels of defoliation from native species of insects promote greater amounts of autumn leaf coloration, they also increase the rate at which trees loose leaves, shortening the duration of autumn leaf displays. This suggests that factors that influence population densities or damage rates by native herbivorous insects, such as drought or densities of insectivorous birds, may create spatial variation in fall color displays in the SNP. This is in contrast to results from our research on gypsy moths, Lymantria dispar, in the SNP in 2008, which indicated that high levels of defoliation by invasive insects reduce leaf coloration in the autumn, as trees reflush green leaves in response to heavy damage. Furthermore, elevation by treatment interactions suggest that that the increased rates of leaf loss and leaf coloration are the result of higher amounts of drought and anthropogenic stressors at higher and lower elevation sites because mid-elevation sites are within a restricted area with considerably lower rates of tourism and no vehicular traffic.

While trends were in the direction predicted (i.e. faster leaf loss and greater amounts and intensity of color on damaged trees), data were statistically significant at $p = 0.1$. Power analysis indicated that samples sizes were too small to detect changes of less than 10% at p-values of 0.05. In order to strengthen the conclusions of this study, a larger number of trees and sites at additional points along the elevation gradient will be added in the following summer. Provided funds are available from external granting agencies for field assistance, additional sampling locations will be added in more remote areas of the SNP to potentially account for the importance of anthropogenic stressors.

For Scientific Studies (not Science Education Activities), were any specimens collected and removed from the park but not destroyed during analysis?

No

Funding specifically used in this park this reporting year that was provided by NPS (enter dollar amount):	**Funding specifically used in this park this reporting year that was provided by all other sources (enter dollar amount):**
$0	$0

List any other U.S. Government Agencies supporting this study or activity and the funding each provided this reporting year:

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